

TDB-ACC-NO: NB920376

DISCLOSURE TITLE: N-Dimensional Scanning and Data Acquisition.

PUBLICATION-DATA: IBM Technical Disclosure Bulletin, March 1992, US

VOLUME NUMBER: 34

ISSUE NUMBER: 10B

PAGE NUMBER: 76 - 78

PUBLICATION-DATE: March 1, 1992 (19920301)

CROSS REFERENCE: 0018-8689-34-10B-76

DISCLOSURE TEXT:

- Up to the present time, scanning tunneling microscope data were usually acquired in the form of $Z = f(x, y)$, where Z represents the topography and x and y are the scan deflections of the tunnel tip in two orthogonal directions. Alternatively, one has acquired spectroscopic data in the form of $I = f(V)$ or $I = f(d)$, where I is the tunneling current, V is the voltage across the tunnel gap, and d is the distance of the tunnel tip from the scanned surface. Usually, such spectroscopies have been implemented using an additional function generator and an additional storage oscilloscope to acquire the data.

- The situation is more complicated in the case of experiments where the tunneling current and the topography are recorded as a function of x , y and the tunnel voltage, for example. Typically, two independent data acquisition systems must be

synchronized to perform

the task, involving special setups for hardware and software. Such an implementation is time-consuming and applicable only to one type of experiment and does not permit on-line changes while tunneling.

- Described herein is a software architecture which enables the configuring of different types of experiments having the general form: $o_1, o_2, \dots = f(p_1, p_2, \dots p_n)$. The observables o_1, o_2 are measured as a function of $p_1 \dots p_n$, mutually orthogonal parameters spanning an n -dimensional parameter space P_n . Each parameter dimension consists of a discrete set of k_j values.

Hence, the parameter space contains a total number of points and is isomorphous to the direct product ***** SEE ORIGINAL FOR MATHEMATICAL EQUATIONS IN DOCUMENT *****

where denotes a subset of .

For each point in P_n' , m observables $o_1 \dots o_m$ are measured. Hence,

the dimension of the data space is

The crucial features of the architecture are:

1. The flexible allocation of functions to the dimensions of the parameter space.

This is especially powerful in that new experiments can be set up with the analog input and output channels at a moment's

notice, with no need to unplug or change connections.

2. The possibility to perform a two-dimensional cut through the parameter space for any observable, for subsequent visualization on a PC screen.

- The data acquisition is structured as a sequence of nested loops, with the innermost loop reading m observables, the next loop setting up parameter 1, and so forth, until the outermost loop (of

parameter n) is reached. In the experiment, the data are acquired sequentially with time. Consequently, the data are mapped to a linear computer memory in exactly the same way.

- Flexibility is achieved by a high-level interface which allows the allocation of a variety of functions in a user-defined sequence.

A common interface is provided to synchronize the functions. For full generality, the functions have to be provided with a pointer to the next outer function (Fig. 1). They are called with an argument (execution flag) which tells the function whether or not it should execute. The output flag indicates whether the function has reached the last sample. If so, the function automatically resets itself to the start value. The output flag will then be used as the input argument of the next function.

- The last operation of the sequence is reading the observables.

The termination condition is reached when the last function $F(p_n)$ exists with the output flag being set (Fig. 2). The acquisition sequence starts with the resetting of all functions. The first function is called after the execution flag has been set unconditionally.

- The integrity of the data set requires that a header be provided containing at least the following information:

1. The number (m) of observables and all values $k_1 \dots k_n$ determining the number of samples required for each dimension.
2. The physical assignment of the m observables.
3. The physical assignment of parameters p_1 to p_n .

Thereby, the dimensionality of the dataset is not limited logically.

SECURITY: Use, copying and distribution of this data is

subject to the
restictions in the Agreement For IBM TDB Database and
Related Computer
Databases. Unpublished - all rights reserved under the
Copyright Laws of the
United States. Contains confidential commercial information
of IBM exempt
from FOIA disclosure per 5 U.S.C. 552(b)(4) and protected
under the Trade
Secrets Act, 18 U.S.C. 1905.

COPYRIGHT STATEMENT: The text of this article is
Copyrighted (c) IBM
Corporation 1992. All rights reserved.